On an Electrical Bench for Physiological Research. By R. MILNE MURRAY, M.A., M.B., F.R.C.P.E.* (With Three Plates.)

This bench is intended to provide an arrangement by which any variety of electrical current may be obtained with the least possible trouble for the purposes of physiological investigation. In the investigation of the physiology of muscle and nerve, for example, it is often necessary to employ measured strengths of galvanic and faradic currents of definite periods. This requirement is met in different ways by different experimenters, and most properly equipped laboratories possess apparatus which, by a little trouble, can be adapted to meet the necessities of each special investigation. When an investigator is working in such a place and has the advantage of skilled assistance, a little thought and ingenuity will usually enable him to arrange the apparatus to suit his purpose. But when one is working alone, or with small resource in the way of skilled help, it is often a matter of some trouble and inconvenience to arrange the appliances for any given experiment, and much time is lost in re-adjusting the instruments to obtain some slight variation of electrical current for stimulation or other purposes. This bench is accordingly arranged in such a way that a current of any required sort, in any direction, of any required strength and rate, may be obtained by adjustment of keys, clamps, &c., which involves a minimum of time and trouble. All these adjustments can be made without leaving the seat at the experimental table, so that mechanical or skilled assistance is quite unnecessary in many researches where they are otherwise indispensable. This is, of course, a matter of

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considerable moment to one working in a private laboratory, and it is probably chiefly by such that its advantages in time and trouble saving will be specially appreciated.

The various parts of the apparatus are fixed to a table made of well polished butternut; the connections between the various keys relays and terminals being made by properly insulated tinned copper wires which pass through and run from point to point under the table.

The rate of interruption of the current (and of consequent stimulation) is determined by the vibrations of a reed A (Plate II.), whose length and period can be altered by means of an adjustable clamp B in which it is held.

A platinum point attached to A dips into the mercury cup C, and closes the circuit of the battery E through the magnet D. This pulls the spring out of the mercury, breaks the circuit, and the spring falls again into the mercury. In this way the reed is kept vibrating at a rate determined by its length between the clamp B and its free end. The details of this part of the instrument are shown in Plate III., fig. 1.

If the block F be plugged, the circuit is confined to the spring and the magnet. But if F is unplugged, then the current will pass round GGG. If, now, any of the blocks $H_1H_2H_3H_4$ be unplugged, the circuit will include the magnet of the relays S,I,K or L respectively.

Let H_1 be unplugged, then the relay S will repeat the vibrations of the spring, and, closing the circuit of the battery N, will actuate the time-marker T, which will record the number and rate of the vibrations of the spring on the drum V.

Now, let the block H_3 be unplugged, the relay K will then act and make the circuit of the battery N_3, which includes the primary coil P of a Du Bois Reymond induction coil. This will induce currents in the secondary coil R, and so excite the nerve-muscle preparation W, whose contractions will be recorded by the lever U, immediately under the markings of the signal T. Thus the rate and moment of stimulation will be recorded by T, while the result of that stimulation will be recorded by U.

Similarly, if H_2 be unplugged, the relay I will close the

circuit of N_2, and galvanic stimuli will be transmitted to the nerve by the electrodes X leading from the commutator V, and the direction of these stimuli can be altered by this commutator.

The effects of the currents transmitted by the relay K through the coil can be adjusted approximately by shifting the coil R in relation to P, and those from I can be adjusted by increasing the strength of the battery N_2, or by inserting resistances in the circuit. But a more accurate method of adjusting the strength of those currents will be described later.

It is sometimes necessary to cut out the induced current in R at the making of the current in P, or the induced current in R at the breaking of this current. This is effected by the relay L, which is a sort of "rocking shunt." The mercury cups M_1 and M_2 in the relay L are joined by wires to the terminals of the secondary coil R. These are shown by the lines mm. Now let the platinum contact M_1 dip deeply into the mercury while that at M_2 is just clear of it. Let the plugs H_3 and H_4 be withdrawn. It will now be seen that the relay L will act at the same moment as the relay K, and the induced current in the secondary, produced at the making of the current in the primary, will find an easy path between the mercury cups M_1 and M_2, because the platinum-point M_2 will be dipped in at the moment the relay K sends the current through the primary P. But the breaking current will have to pass through the nerve, because the relay L will give at the same time as K, and the point M_2 will be withdrawn from the cup, opening the shunt between M_1 and M_2.

By reversing the adjustment of M_1 and M_2, the "breaking" current may be cut out and the "making" transmitted.

The mode of adjusting the strength of the currents indicated above is sufficiently accurate for demonstration, but is deficient in accuracy for refined research. For this purpose in the bench under consideration, advantage is taken of the principle of the Wheatstone's Bridge.

For adjusting the strength of the Faradic stimulation, the arrangement is as follows :—

The coils P and S (the primary and secondary), Plate

III., fig. 2, are placed at a suitable distance from each other. The current from the battery E is sent through the bridge QORX, of which OQ is the wire and X and R are equal resistance coils. The primary coil P is placed in the position of the galvanometer of the bridge, and the circuit is made and broken by the relay K.

Now, if X and R are equal to each other, and A is in the middle of OQ, then no current will pass through P, and consequently the effect on S will be nil. But, if A be moved ever so little to the one side, then the balance will be broken, some current will flow through P, and a certain effect will be produced in S. The further A is moved from the middle the stronger will be the current in P, and the relative values can be determined for any position of A by the ordinary formula for the Wheatstone's Bridge.

The actual strength of current passing through the primary coil can be read off the milliampéremeter G, which is included in the circuit.

The actual bridge connected with this bench (Plate III., fig. 3) is a circular one. The wire is of platinum-iridium alloy, and is divided into 1000 parts, and the slider is adjusted by a coarse and a fine adjustment—the latter moved by a micrometer screw. The resistances X and R are two sets of coils of value from 1 to 200 ohms each.

By a simple "turn-over" switch the relay I, Plate II., can be connected with the bridge, and galvanic currents of any required gradation can be sent through the nerve at will.

By suitable arrangements the whole mechanism of the bench is under complete control of the observer while sitting in front of the drum and recording apparatus on the experimental table. All adjustments can be made without any assistance whatever, and, save the shifting of the length of the reed, everything can be done without rising from the seat.

The movements of the relays can be controlled at a distance by means of the switch SW, Plate II., which is really a short circuiting key.

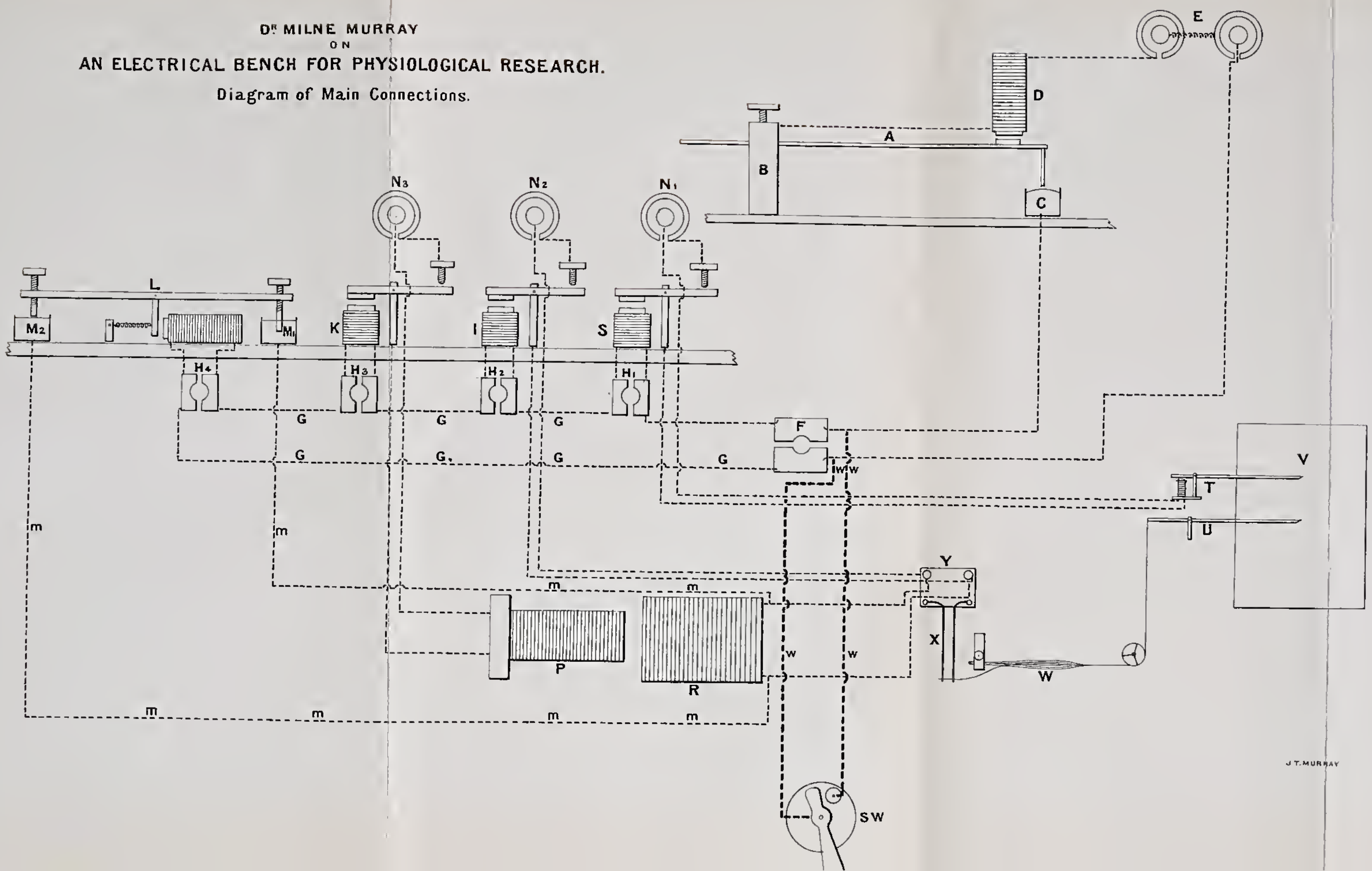
This is connected by a pair of thick wires, ww, to the plug F, and can be attached to the experimental table at any distance from the bench. When this switch is closed

the current is cut off from the relays which cease acting, while, of course, the action of the spring is not interfered with. On opening SW the current from the spring A will immediately flow through any of the relays whose circuit may be open.

A general view of the bench is given in Plate I.

Dr MILNE MURRAY
ON
AN ELECTRICAL BENCH FOR PHYSIOLOGICAL RESEARCH.

Diagram of Main Connections.



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ON

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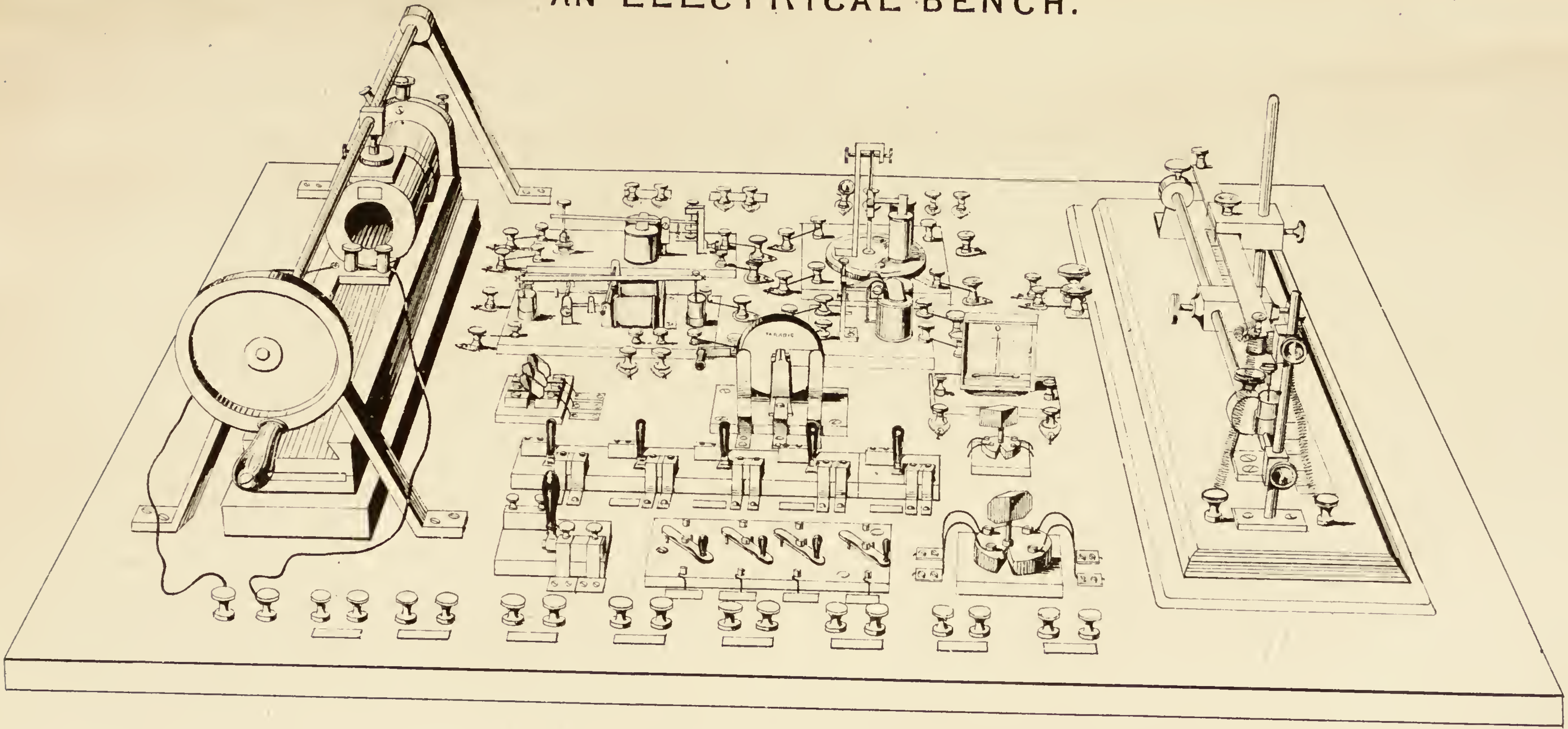

GENERAL VIEW OF BENCH.

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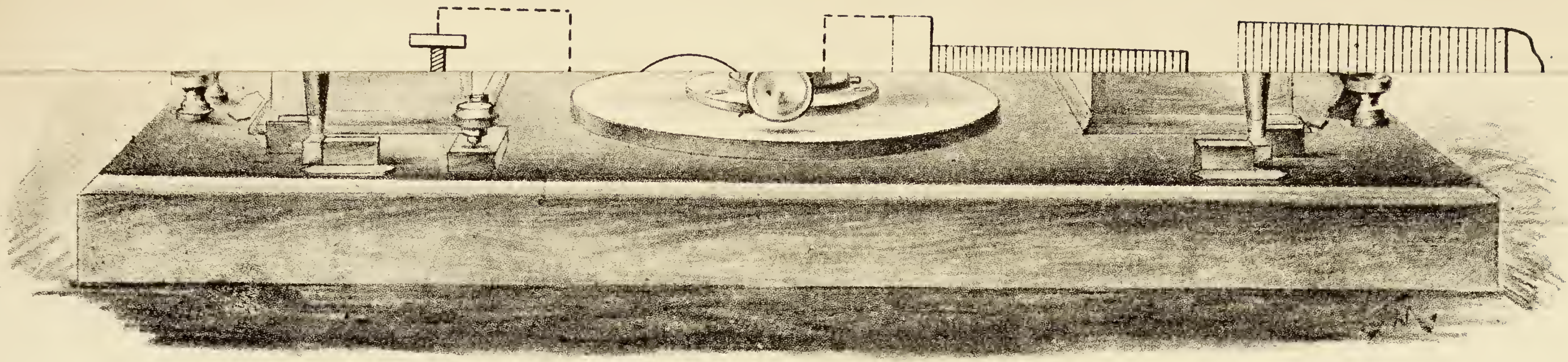

Fig. 3. CIRCULAR BRIDGE.

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